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ABSTRACT

The Science Teacher Inventory of Need (STIN) was developed specifically to assess the perceived needs of science teachers in developing nations. The purpose of this reported study was to apply factor analysis to the perceived needs data collected from a sample of Malaysian secondary science teachers in order to clarify further the factorial composition and construct validity of the STIN. The 76 closed items of the STIN were originally arranged in seven categories chosen to represent typical stages in systematic instruction as these are explicated in the literature. The exploratory factor analysis reported showed 72 of those items to contribute to the variance. The six factor solution suggests that the STIN item could be more appropriately arranged for delivery and possibly for scoring purposes. Generally, data on the validity of the STIN appear to be adequate to warrant its continued use in assessing the perceived needs of science teachers. The instrument is included in the report. (ML)

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THE CONSTRUCT VALIDITY OF THE SCIENCE TEACHER INVENTORY OF NEED: RECOMMENDATIONS AND MODIFICATIONS[1]

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The Construct Validity of the Science Teacher Inventory of Need: Recommendations and Modifications

Abstract

The Science Teacher Inventory of Need (STIN) was developed specifically to assess the perceived needs of science teachers in developing nations. During that process factor analysis was completed post hoc with data from a heterogeneous population of Jordanian science teachers to provide evidence of the construct validity of the STIN. The present study was conducted to clarify further the factorial composition and construct validity of the STIN. Data collected from 1162 (78% returns from a 20% randomized, cluster sample of Malaysian secondary science teachers) were factor analyzed via the principal components method with varimax rotation. Six nontrivial factors accounting for 91.9% of the total variance were identified, with 72 of the 76 closed items found to be interpretable. Item rearrangement under the six factors is suggested. Also, confirmatory factor analysis is suggested to test the obtained factor structure. In the interim, the extant data on STIN reliability and validity warrant its continued use to assess the perceived need of science teachers.

The Construct Validity of the Science Teacher Inventory of Need: Recommendations and Modifications

Background

Survey methodology is the most common means used to determine teachers' perceived needs. Although often times difficult to secure, instrument construct validity is critically important in such studies. Within the domain of science teacher needs, the Science Teacher Inventory of Need (STIN) (Zurub, 1982; Zurub and Rubba, 1983) recently has been applied to assess the perceived needs of the science teacher populations of Jordan (Zurub and Rubba, 1984) and Malaysia (Abu Bakar, 1984), with similar applications in other developing nations being planned.

The STIN was designed specifically for use in developing nations (Zurub, 1982; Zurub and Rubba, 1983). During that process, factor analysis was employed to collect evidence of its construct validity. The application of the principal components factor analysis technique with varimax rotation to perceived need data collected from secondary Jordanian science teachers yielded a total of 18 factors (100% of the variance). The Scree Test showed nine of those factors to be significant (nontrivial) and to account for 84.9% of the total variance in the STIN. Inventory item communalities ranged from 0.20 to 0.87. Seventy-one of the STIN items were established to be interpretable across the nine factors.

Purpose

Two difficulties exist with regard to the original factor analysis completed on the STIN and hence with the construct validity of the instrument. First, the factor analysis was completed post hoc. Post hoc interpretations of factor structures are not to be regarded as final, but only as leads for further factor analytic studies (Gorsuch, 1983; Rummel, 1970). Second, the subjects (Jordanian science teachers)

comprised an extremely heterogeneous population with respect to certain demographic variables (e.g., age, gender, education, number of years of teaching experience). These variations can introduce correlations between variables and can generate factors (Nunnally, 1967). Notwithstanding the tentative interpretations placed upon the nine factors identified to exist within the STIN following the original factor analysis, the evidence for the construct validity of the STIN is provisional.

The purpose of the present study was to apply factor analysis to the perceived needs data collected by Abu Bakar (1984) from a sample of Malaysian secondary science teachers in order to clarify further the factorial composition and construct validity of the STIN. Such information could have important implications for future revision of the STIN.

Procedure

Instrument

The STIN (ERIC Document ED 241263) consists of 83 items grouped under the following seven categories (Please see Appendix A for the STIN):

A. Specifying Objectives for Science Instruction

B. Diagnosing and Evaluating Learners for Science Instruction

C. Planning Science Instruction

D. Delivering Science Instruction

E. Managing Science Instruction

F. Administering Science Instructional Facilities

G. Improving One's Competence as a Science Teacher.

Seventy-six of the items describe tasks and activities which science teachers are called upon to perform in the course of carrying out their instructional duties. Each item consists of a task description which has attached to it a coded scale, in which NF = not familiar with the task, 1 = no need, 2 = little need, 3 = moderate need, and

4 = great need. A blank is included adjacent to each of these items which respondents can use to specify further any item-associated need. At the end of each of the seven categories of items is an open-ended item which respondents can use, to register any need they could not fit into other items in the category.

A bilingual form of the STIN was used in this study, wherein the directions and items were written in both English and Bahasa Malaysia, one directly under the other. (The form of the STIN used by Zurub (1982) had the directions and items written in English and Arabic). The translation into Bahasa Malaysia was checked by two independent judges, both of whom previously had been employed translating educational materials from English to Bahasa Malaysia or from Bahasa Malaysia to English.

Subjects:

The subjects were selected from the population of science teachers in the 801 fully government assisted secondary schools within the 12 states of Peninsular Malaysia. A cluster sampling technique was employed because the individual names of the science teachers were not available. That is, all science teachers in a 20% random sample of the schools (n=161) selected proportionally across the 12 states, were included in the sample.

Each of the 161 schools was reached to determine the number of science teachers composing the sample--a total of 1491 science teachers. The bilingual form of the STIN was distributed to teachers, along with a cover letter, and was collected from them via their school principal. The principals returned the completed instruments by mail within three weeks. Usable STINS were returned by 1162 (77.93%) of the science teachers. The percentage of usable returns ranged from 62.71% to 91.67% across the 12 states.

These science teachers were from 130 (80.75%) of the 161 secondary schools in the sample. The group comprised 526 females (45.3%) and 632 males (54.4%), who ranged in age from 19 to 54 years (mean = 30.4) with 720 of them having eight years of experience or less. The number and precentage of teachers with experience in the various science subject areas were as follows: 513 (44.1%) integrated science, 157 (13.5%) general science, 145 (12.5%) biology, 156 (13.4%), chemistry, 162 (13.9%) physics, and 29 (2.6%) unidentified science subject areas.

Data Analysis

The responses coded as 1,2,3, or 4 to the 76 closed inventory items were scored as marked. For the purposes of this study, the NF (not familiar) responses were assigned the value of 5. The data were factored by the principal components method with varimax rotation via SPSS. This procedure yielded 11 factors which accounted for almost 100% of the variance. Both the Scree Test (Rummel, 1970) and the popular criterion of eigenvalues greater than 1.00 (Kim and Mueller, 1978) showed six of those factors to be significant (nontrivial) and to account for 91.9% of the total variance in the STIN. Table 1 presents the factors with their eigenvalues and corresponding percentages of variance in its left most columns.

Insert Table 1 about here

The item loading criterion of .30 (Gorsuch, 1983; Nunnally, 1967) was used to determine which items were interpretable. Seventy-two items were found to be interpretable. The distribution of those items across the six factors is shown in the right most columns of Table 1, along with the name which was synthesized for each factor based upon its respective items.

Discussion

The 76 closed items of the STIN were originally arranged in seven categories chosen to represent typical stages in systematic instruction as these are explicated in the literature. The exploratory factor analysis reported here showed 72 of those items to contribute reliable variance. Nonetheless, it may not be advantageous to delete the four "unreliable" items, i.e., C-5, D-13, D-17, and E-10, given those items were content validated during development of the STIN (Zurub and Rubba, 1983). Still, the six factor solution suggests that the STIN items could be more appropriately arranged for delivery and possibly for scoring purposes.

Gorsuch (1983, Chapter 7) has suggested that an exploratory factor analysis subsequently should be tested by subjecting new data to a confirmatory factor analysis. Thus, further research is necessary to test the factor structure obtained in this study. In the interim, the empirical data provided by Abu Bakar (1984) and by Zurub and Rubba (1983) on STIN reliability--0.95 and 0.98, respectively--and on the validity of the STIN appear to be adequate to warrant its continued use in assessing the perceived needs of science teachers.

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Table I

Resultant STIN Factors with Eigenvalues,
Percent of Variance, and Identification of Items Having Factor
Loadings .30 or Higher

Factor	Eigenvalue	Percent of Variance	Items	Factor Name
1	31.279	67.7	A-3; B-7,8,9; C-2,3,4,6; D-1,2,3,4, 5,6,7,15, 16,18; E-1,2,4,5,6,7,8,9; F-1,2,3,4,5,6,7;	Evaluating, Planning, Delivering, and Managing Science Instruction
2	3.768	8.2	G-1,2,3,4,5, 6,7,8,9,10;	Updating One's Scientific and Technological Knowledge and skills
3	2.973	6.4	B-1,2,3,4,5,6; C-1,7; D-12; E-3;	Diagnosing and Evaluating Students for Science Instruction
4	2.006	4.3	G-11,12,13, 14,15,16;	Updating One's Background in the Educational Foundations of Science Instruction
5	1.242	2.7	B-10; D-8,9,10,11, 14;	Additional Strategies for Delivering Science Instruction
6	1.213	2.6	A-1,2,4, 5,6,7;	Specifying Objectives for Science Instruction
	Total	91.9		

APPENDIX A

STIN

(Science Teacher Inventory of Need*)

The STIN was developed to assess science teachers' perceptions of their professional needs. It contains 83 items grouped under seven instruction related categories. Each item is composed of a statement, a coded scale, and a blank. The statement portion of an item describes a task a science teacher may be called upon to perform. Following the statement is the coded scale "NF 1 2 3 4" where:

NF = Not Familiar with the task
1 = No Need
2 = Little Need
3 = Moderate Need
4 = Great Need

The blank is found below the statement. Here is an example item.

0.0 Employ programmed instruction NF 1 2 3 4

_____

In responding to an item you are asked:

1. to circle the <u>one</u> code that best designates the <u>degree</u> to which <u>you</u> have a need for help with the task; and,
2. <u>if you wish</u>, to detail the nature of your need by listing specific topics in the blank.

Let's consider another example.

0.0 Provide instruction in microscopic technique NF 1 2 (3) 4

Gram's Staining Technique

The science teacher who responded to this item felt he/she had a "Moderate Need" for help on the task "Provide instruction in microscopic technique." The science teacher particularly wanted help on how to use Gram's Staining Technique. If a science teacher were "Not Familiar" with the task described in the item, he/she would circle the "NF" code.

PLEASE RESPOND TO EACH OF THE ITEMS ON THE FOLLOWING PAGES. YOU MAY MARK YOUR RESPONSES IN THIS BOOKLET <u>UNLESS</u> YOU HAVE BEEN SUPPLIED WITH A SEPARATE ANSWER/RESPONSE SHEET.

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NF	1	2	3	4
Not Familiar	No Need	Little Need	Moderate Need	Great Need

A. SPECIFYING OBJECTIVES FOR SCIENCE INSTRUCTION

1. Specify a rationale for teaching science in school

_____ NF 1 2 3 4

2. Establish a science curriculum/program

_____ NF 1 2 3 4

3. Determine the content of a science course

_____ NF 1 2 3 4

4. Write learning objectives which specify knowledge students are to develop as a function of science instruction

_____ NF 1 2 3 4

5. Write learning objectives which specify attitudes students are to develop as a function of science instruction

_____ NF 1 2 3 4

6. Write learning objectives which specify skills students are to develop as a function of science instruction

_____ NF 1 2 3 4

7. Arrange instructional objectives in the sequence in which they will be addressed during science instruction

_____ NF 1 2 3 4

8. Please list and rate any other needs you have relative to specifying objectives for science instruction

_____ NF 1 2 3 4

_____ NF 1 2 3 4

B. DIAGNOSING AND EVALUATING LEARNERS FOR SCIENCE INSTRUCTION

1. Design assessment items/procedures which validly assess science instructional objectives

_____ NF 1 2 3 4

NF	1	2	3	4
Not Familiar	No Need	Little Need	Moderate Need	Great Need

2. Use assessment data to determine student readiness for science instruction (physical, intellectual, social, emotional)

_____ NF 1 2 3 4

3. Use assessment data to diagnose science learning difficulties (physical, intellectual, social, emotional)

_____ NF 1 2 3 4

4. Arrange assessment items into a test

_____ NF 1 2 3 4

5. Construct and use a science assessment item file/bank

_____ NF 1 2 3 4

6. Arrange informal assessment situations in science teaching

_____ NF 1 2 3 4

7. Use oral questions in science instruction

_____ NF 1 2 3 4

8. Administer tests and quizzes

_____ NF 1 2 3 4

9. Utilize student assessment data in determining grades

_____ NF 1 2 3 4

10. Select, administer and interpret standardized test instruments

_____ NF 1 2 3 4

11. Please list and rate any other needs you have relative to diagnosing and evaluating learners for science instructions

_____ NF 1 2 3 4

_____ NF 1 2 3 4

NF	1	2	3	4
Not Familiar	No Need	Little Need	Moderate Need	Great Need

C. PLANNING SCIENCE INSTRUCTION

1. Use student readiness data to plan for science instruction

_____ NF 1 2 3 4

2. Develop an instructional plan for a unit (e.g. six weeks) of science instruction

_____ NF 1 2 3 4

3. Select appropriate instructional strategies for science instruction

_____ NF 1 2 3 4

4. Develop a lesson plan for a single science class session

_____ NF 1 2 3 4

5. Select commercially prepared instructional materials for science instruction

_____ NF 1 2 3 4

6. Prepare teacher made instructional materials for science instruction

_____ NF 1 2 3 4

7. Arrange the physical environment for science instruction

_____ NF 1 2 3 4

8. Please list and rate any other needs you have relative to planning science instruction

_____ NF 1 2 3 4

_____ NF 1 2 3 4

D. DELIVERING SCIENCE INSTRUCTION

1. Motivate students to learn science

_____ NF 1 2 3 4

NF	1	2	3	4
Not Familiar	No Need	Little Need	Moderate Need	Great Need

2. Use an inquiry teaching strategy in teaching science

_____ NF 1 2 3 4

3. Conduct a science laboratory session

_____ NF 1 2 3 4

4. Deliver a lecture/illustrated talk on a science topic

_____ NF 1 2 3 4

5. Demonstrate a science concept

_____ NF 1 2 3 4

6. Demonstrate a science process skill

_____ NF 1 2 3 4

7. Demonstrate a science manipulative skill

_____ NF 1 2 3 4

8. Direct a field trip in teaching science

_____ NF 1 2 3 4

9. Employ simulation techniques in teaching science

_____ NF 1 2 3 4

10. Employ team teaching in science class

_____ NF 1 2 3 4

11. Employ value clarification strategies science teaching

_____ NF 1 2 3 4

12. Employ individualized instructional strategies in teaching scien

_____ NF 1 2 3 4

13. Conduct a group discussion/panel discussion in teaching science

_____ NF 1 2 3 4

NF	1	2	3	4
Not Familiar	No Need	Little Need	Moderate Need	Great Need

14. Employ peer tutoring in science teaching

_____ NF 1 2 3 4

15. Use audio-visual equipment to support science instruction

_____ NF 1 2 3 4

16. Use area/regional resources to support science instruction

_____ NF 1 2 3 4

17. Use computers/teaching machines to deliver science instruction

_____ NF 1 2 3 4

18. Use library/media center to support science instruction

_____ NF 1 2 3 4

19. Please list and rate any other needs you have relative to delivering science instruction

_____ NF 1 2 3 4

_____ NF 1 2 3 4

E. MANAGING SCIENCE INSTRUCTION

1. Manage a science instructional budget

_____ NF 1 2 3 4

2. Provide for students' safety in the science laboratory

_____ NF 1 2 3 4

3. Attend to students' physical, emotional and social needs in science instruction

_____ NF 1 2 3 4

4. Keep student records

_____ NF 1 2 3 4

NF	1	2	3	4
Not Familiar	No Need	Little Need	Moderate Need	Great Need

5. Communicate student science learning progress to the student, administrators and parents

_____ NF 1 2 3 4

6. Supervise tutoring of science students

_____ NF 1 2 3 4

7. Supervise a para-professional in the science classroom

_____ NF 1 2 3 4

8. Maintain student discipline

_____ NF 1 2 3 4

9. Evaluate one's own instructional effectiveness as a science teacher

_____ NF 1 2 3 4

10. Use a computer to manage instruction

_____ NF 1 2 3 4

11. Please list and rate any other needs you have relative to managing science instruction

_____ NF 1 2 3 4

_____ NF 1 2 3 4

F. ADMINISTERING SCIENCE INSTRUCTIONAL FACILITIES AND EQUIPMENT

1. Organize a science laboratory room

_____ NF 1 2 3 4

2. Set up a laboratory supply order, storage and retrieval system

_____ NF 1 2 3 4

3. Maintain science laboratory equipment

_____ NF 1 2 3 4

4. Construct science laboratory equipment

_____ NF 1 2 3 4

5. Select science laboratory equipment for student use

_____ NF 1 2 3 4

NF	1	2	3	4
Not Familiar	No Need	Little Need	Moderate Need	Great Need

6. Identify sources of free and inexpensive science instructional materials

_____ NF 1 2 3 4

7. Select supportive materials (library books, films) for science instruction

_____ NF 1 2 3 4

8. Maintain live organisms for science instruction

_____ NF 1 2 3 4

9. Please list and rate any other needs you have relative to administering science instructional facilities and equipment

_____ NF 1 2 3 4

_____ NF 1 2 3 4

G. IMPROVING ONE'S COMPETENCE AS A SCIENCE TEACHER

1. Update one's scientific knowledge in biology

_____ NF 1 2 3 4

2. Update one's scientific knowledge in chemistry

_____ NF 1 2 3 4

3. Update one's scientific knowledge in earth science/geology

_____ NF 1 2 3 4

4. Update one's scientific knowledge in physics

_____ NF 1 2 3 4

5. Update one's scientific skills in biology

_____ NF 1 2 3 4

6. Update one's scientific skills in chemistry

_____ NF 1 2 3 4

NF	1	2	3	4
Not Familiar	No Need	Little Need	Moderate Need	Great Need

7. Update one's scientific skills in earth science/geology

_____ NF 1 2 3 4

8. Update one's scientific skills in physics

_____ NF 1 2 3 4

9. Update one's knowledge of man's utilization of science/technology

_____ NF 1 2 3 4

10. Update one's knowledge of science related career opportunities for students

_____ NF 1 2 3 4

11. Update one's knowledge of science related societal issues

_____ NF 1 2 3 4

12. Update one's background in theories of cognitive development, learning and instruction

_____ NF 1 2 3 4

13. Update one's background in curriculum development

_____ NF 1 2 3 4

14. Update one's background in the philosophy of education

_____ NF 1 2 3 4

15. Update one's background in the philosophy of science

_____ NF 1 2 3 4

16. Work towards a degree in science education

_____ NF 1 2 3 4

17. Please list and rate any other needs you have relative to improving one's competence as a science teacher

_____ NF 1 2 3 4

_____ NF 1 2 3 4

Thank you for completing this instrument!